REQUEST FOR FILING A PATENT APPLICATION UNDER 37 CFR 1.60

PTO/SB/13 (11-90)

DOCKET NUMBER	ANTICIPATED CLASIFICATION OF THIS APPLICATION		PRIOR APPLICATION EXAMINER	ART UNIT
	CLASS	SUBCLASS		
MJV-117-3-Div.	416		Ninh H. Nguyen	3745

Address to:
Commissioner of Patents and Trademarks
Washington, D.C. 20231

This is a request for filing a ☐ continuation ☒ divisional application under 37 CFR 1.60, of pending prior application Number 09/130937, filed on 8/7/98 entitled Advanced Motor Driven Impeller Pump for Moving Metal in a Bath of Molten Metal

1. Enclosed is a copy of the latest inventor-signed prior application, including a copy of the oath or declaration showing the original signature or an indication it was signed. I hereby verify that the attached papers are a true copy of the latest signed prior application number 09/130937 and further that all statements made herein of my own knowledge are true; and further that these statements were made with the knowledge that willful false statements and the like are made punishable by fine or imprisonment, or both, under section 1001 of Title 18 of the United States Code and that such willful statements may jeopardize the validity of the application or any patent issuing thereon.

CLAIMS	(1) FOR	(2) NUMBER FILED	(3) NUMBER EXTRA	(4) RATE	(5) CALCULATIONS
	TOTAL CLAIMS	7 -20=	0	x 0	$ 0
	INDEPENDENT CLAIMS	1 -3=	0	0	0
	MULTIPLE DEPENDENT CLAIMS (if applicable)				
			BASIC FEE		380.00
			Total of above Calculations =		0
			TOTAL =		380.00

2. ☒ A verified statement to establish small entity status under 37 CFR 1.9 and 1.27
   ☐ is enclosed.
   ☒ was filed in prior application number 09/130937 and such status is still proper and desired (37 CFR 1.28(a)).

3. ☐ The Commissioner is hereby authorized to charge any fees which may be required under 37 CFR 1.16 and 1.17, or credit any overpayment to Deposit Account No. _____. A duplicate copy of this sheet is enclos

4. ☒ A check in the amount of $ 380.00 is enclosed.

5. ☒ Cancel in this application original claims 1-34 and 42-45 of the prior application before calculating the filing fee. (At least one original independent claim must be retained for filing pur

6. ☒ Amend the specification by inserting before the first line the sentence: "This application is a ☐ continuation ☒ division of application number 09/130937, filed 8/7/98, (status, abandoned, pending, etc.)."

7. ☐ Transfer the drawings from the pending prior application to this application and abandon said prior application as o the filing date accorded this application. A duplicate copy of this sheet is enclosed for filing in the prior application. (May only be used if signed by person authorized by 37 CFR 1.138 and before payment of issue fee.)

(REQUEST FOR FILING A PATENT APPLICATION UNDER 37 CFR 1.60, PAGE 2)

8. [X] ~~New formal~~ Informal drawings are enclosed.

9. [ ] Priority of foreign application number _____, filed on _____ in _____ is claimed under 35 U.S.C. 119.

   [ ] The certified copy has been filed in prior application number ___/_____, filed _____

10. [ ] A preliminary amendment is enclosed.

11. [X] The prior application is assigned of record to Alphatech, Inc., 526 Riverview Trail, Cadiz, KY 42211.

12. [ ] Also enclosed:

13. [X] The power of attorney in the prior application is to: Charles W. Chandler 33150 Schoolcraft, Livonia, MI 48150.

    a. [X] The power of attorney appears in the original papers in the prior application.

    b. [ ] Since the power does not appear in the original papers, a copy of the power in the prior application is enclosed.

    c. [X] Address all future communications to: (May only be completed by applicant, or attorney or agent of record.)

9/15/99
Date

Charles W. Chandler
Typed or printed name of signator

Signature

Address of signator:

[ ] Inventor(s)
[ ] Assignee of complete interest
[X] Attorney or agent of record
[ ] Filed under 37 CFR 1.34(a)

Charles W. Chandler
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PTO/SB/09 (6-95)
Approved . / use through 07/31/96. OMB 0651-0031
Patent and Trademark Office: U.S. DEPARTMENT OF COMMERCE

VERIFIED STATEMENT CLAIMING SMALL ENTITY STATUS (37 CFR 1.9(f) & 1.27(b))--INDEPENDENT INVENTOR

Docket Number (Optional) MJV-117-A

Applicant or Patentee: Jorge A. Morando

Application or Patent No.: _____

Filed or Issued: _____

Title: ADVANCED MOTOR DRIVEN IMPELLER PUMP FOR MOVING METAL IN A BATH OF MOLTEN METAL

As a below named inventor, I hereby declare that I qualify as an independent inventor as defined in 37 CFR 1.9(c) for purposes of paying reduced fees to the Patent and Trademark Office described in:

- [X] the specification filed herewith with title as listed above.
- [ ] the application identified above.
- [ ] the patent identified above.

I have not assigned, granted, conveyed or licensed and am under no obligation under contract or law to assign, grant, convey or license, any rights in the invention to any person who would not qualify as an independent inventor under 37 CFR 1.9(c) if that person had made the invention, or to any concern which would not qualify as a small business concern under 37 CFR 1.9(d) or a nonprofit organization under 37 CFR 1.9(e).

Each person, concern or organization to which I have assigned, granted, conveyed, or licensed or am under an obligation under contract or law to assign, grant, convey, or license any rights in the invention is listed below:

- [ ] No such person, concern, or organization exists.
- [X] Each such person, concern or organization is listed below.

Alphatech, Inc.
526 Riverview Trail
Cadiz, KY 42211

Separate verified statements are required from each named person, concern or organization having rights to the invention averring to their status as small entities. (37 CFR 1.27)

I acknowledge the duty to file, in this application or patent, notification of any change in status resulting in loss of entitlement to small entity status prior to paying, or at the time of paying, the earliest of the issue fee or any maintenance fee due after the date on which status as a small entity is no longer appropriate. (37 CFR 1.28(b))

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application, any patent issuing thereon, or any patent to which this verified statement is directed.

Jorge A. Morando		
NAME OF INVENTOR	NAME OF INVENTOR	NAME OF INVENTOR
Signature of inventor	Signature of inventor	Signature of inventor
Date: Dec. 6 1998	Date	Date

ADVANCED MOTOR DRIVEN IMPELLER PUMP FOR MOVING METAL IN A BATH OF MOLTEN METAL

Background of the Invention

This invention is related to mechanical pumps for moving or pumping metal such as aluminum or zinc in a bath of molten metal, and more particularly to such a pump in which a motor supported above the bath drives a vertical stainless steel shaft. The lower end of the shaft drives the propeller to create a stream of molten metal. A ceramic sleeve shields the stainless steel shaft to protect it from the corrosive effects of the heated molten metal, as well as forming a loose fit with the shaft to accommodate differences in the thermal expansion characteristics between the ceramic and the stainless steel.

Mechanical power driven pumps for moving metal in a bath of molten metal conventionally have a relatively short life because of the destructive effects of the molten metal on the pump components. If the pump shaft connecting the motor to an impeller is formed of any steel to provide sufficient torque to move the impeller in the molten metal, the steel has a short life because it is chemically attacked by the molten metal. If the steel shaft is shielded by a protective coating of a ceramic material, then the different thermal expansion characteristics of the steel and the ceramic causes the ceramic to shatter in a relatively short time.

A shaft made of graphite alone will burn at the metal surface. A shaft made of ceramic alone does not have sufficient tensile, torque or impact strength to overcome the stresses normally encountered when pumping molten metal.

A pump housing submerged in molten metal and made of graphite or ceramic material to withstand the heat, tends to rise in the metal bath because the ceramic has a lower density than the metal. In order to prevent the pump housing from rising in the metal, it is desirable to mount a series of vertical legs between the pump housing and an overhead supporting structure. In addition the legs (or posts as they are also called) should be strong enough to overcome the tensile stresses created during installation and subsequent removal of the pump in the molten metal bath. Such legs experience problems similar to that of an unshielded pumping shaft, that is, if they are made of an uncoated steel they have a short life because the steel is attacked by the molten metal. If they are made entirely of graphite, the legs will burn at the metal interface. If a leg is made entirely of a ceramic material having good heat resistant characteristics, it has insufficient tensile strength to ensure a long life.

Summary of the Invention

The broad purpose of the present invention is to provide a shielded stainless steel driving shaft for a centrifugal impeller-type pump immersed in a molten metal bath.

Another object of the invention is to provide an improved stainless steel leg (post) for supporting and preventing the pump housing from rising in the molten metal.

Still another object of the invention is to provide an improved static inlet filter configuration for an impeller pump immersed in a molten metal bath.

Still another object of the invention is to provide a ceramic shield surrounding a graphite leg and forming an inert gas chamber around the leg. An inert gas is delivered to the gas chamber to provide an oxygen-free environment around those graphite components of the leg that may tend to burn at the temperatures of the surface of the molten metal bath.

Still another object of the invention is to provide a dynamic filter for the inlet opening of the impeller of a pump mounted in a molten metal bath. The filter rotates with the impeller without interfering with the pumping vanes. Slinger ribs provided on the dynamic filter deflect debris attempting to enter the strainer apertures to prevent their passage into the pump housing.

Still further objects and advantages of the invention will become readily apparent to those skilled in the art to which the invention pertains upon reference to the following detailed description.

Description of the Drawings

The description refers to the accompanying drawings in which like reference characters refer to like parts throughout the several views and in which:

FIGURE 1 is a longitudinal sectional view of an impeller pump immersed in a bath of molten metal and illustrating the preferred embodiment of the invention;

FIGURE 2 is an enlarged view of the tongue carried on the lower end of the driving shaft for rotating the impeller;

FIGURE 3 is a view as seen along lines 3-3 of Figure 2;

FIGURE 4 is a longitudinal sectional view of an impeller pump immersed in a bath of molten metal and illustrating a graphite quill shaft design with an external ceramic shield protection;

FIGURE 5 is a view of an unshielded leg used for connecting a pump housing to an overhead structure;

FIGURE 6 is a view illustrating a split ring employed for connecting the lower end of the leg to the pump housing;

FIGURE 7 is an enlarged view as seen along lines 7-7 of Figure 5;

FIGURE 8 is a view of another arrangement for connecting the support leg to the pump housing;

FIGURE 8A is a view of a graphite leg for supporting the pump housing, utilizing graphite cement for connecting the lower end of the leg to the pump housing;

FIGURE 9 is a view as seen along lines 9-9 of Figure 8A;

FIGURE 10 is a view of a quill-shaft, ceramic support leg for the pump housing;

FIGURE 11 is a view of another form of a quill-shaft, ceramic support leg for the pump housing;

FIGURE 11A is a view of another form of a quill-shaft ceramic or graphite support leg for the pump housing;

FIGURE 12 is an enlarged fragmentary view of a graphite inert quill-shaft support leg for the pump, having an oxygen-free chamber to eliminate oxidation of the graphite components;

FIGURE 13 is a view of a dynamic strainer for the pump

FIGURE 14 is a bottom view of Figure 13; and

FIGURE 15 is an enlarged view of the internal pumping vanes of the embodiment of Figure 13.

Description of the Preferred Embodiment

Referring to the drawings, Figure 1 illustrates a preferred impeller pump 10 having a lower pumping end disposed in a bath of molten metal 12 such as aluminum. The bath has a top metal level 14. Typically the bath operates at a temperature not in excess of 1800° F. The bath is contained by a pot having a floor 16. An electrically driven motor 80 is supported in any suitable location above the pump cover plate 18, and is connected by a coupling 22 to a stainless steel pumping or driving shaft 24. The shaft is supported in an opening 26 in the pump cover plate. The shaft has a sufficient length that the upper end is supported above cover plate 18 and its lower end is disposed in the bath of molten metal 12.

A pump housing assembly 28 includes a housing 30 and a vane-type pumping member 32 disposed in the housing. The shaft is drivingly connected to the pumping member to rotate it in the housing in order to produce a stream of molten metal that enters the housing adjacent the floor of the pot through an inlet opening 34, into a pumping chamber 36 and toward an outlet opening 38 in the direction of arrows 40.

The pumping member includes a ceramic impeller 33 which carries pumping vanes 44. Bearing means 46 carried in a shoulder 48 of the housing 30 engage a ceramic end driver 42 cemented to a vertical outer tubular ceramic shield 50. The lower end of the end driver 42 is closed off and fits into pumping member 32. The

upper end of the shield extends upwardly through cover plate 18. End driver 42, after cementing, forms a single integral part of shaft assembly 20 together with shield 50, tubular spacer shield 52, steel driving shaft 24 and tongue 58.

Inner ceramic tubular shield 52 is cemented to the inside of the outer shield 50. The upper end of the inner shield is flush with the upper end of the outer shield. The inner tubular shield is shorter than the outer shield to form an annular shoulder 54.

The lower end of the drive shaft 24 is threaded at 56 as illustrated in Figure 1. The threaded end 56 extends below shoulder 54. A stainless steel tongue 58 is threadably mounted on threaded end 56 and seated on shoulder 54 in a manner that will be described.

Referring to Figure 2, the inside bottom of the outer shield forms a chamber 60. Tongue 58 is disposed in the chamber. Cement 62 is disposed in the chamber and has a socket 64 generally corresponding to the configuration of the tongue but slightly larger to provide for a clearance between the tongue and the socket to allow for thermal expansion differences.

As can be seen in Figure 2, the bore of the spacer shield 52 is larger than the diameter of the shaft 24 to provide a clearance which permits the shaft to expand in response to heat without creating an expansion tensile stress on the spacer shield 52. Similarly, the tongue has a clearance that permits it to expand in response to heat without creating an expansion interference stress with the cement.

Referring to Figure 1, coupling 22 forms the connection between the motor shaft and the shield assembly 20 that rotates impeller body 32 with impeller vanes 44. The

shaft with the shield in turn rotates the propeller body 42 and propeller vanes 44. The torque from the shaft is transmitted through the tongue to the body of cement to the end driver 42, that is through the lower end of the shaft to the impeller. The shaft has a sufficient torque characteristic for driving the impeller in molten metal.

The inner spacer shield is located to form an annular air chamber 76 between the shaft and the inner shield along its full length. The air chamber has a size chosen to permit the stainless steel shaft to fully expand in the bath of molten metal without applying any expansion pressure on the ceramic shield. The shaft is then fully shielded by heat-resistant and molten metal resistant ceramic.

Figure 4 illustrates a modified impeller pump 10'.

Bearing means 46 carried in a shoulder 48 of the housing 30 engage an outer graphite sleeve-like shaft 50'. The lower end of shaft 50' is closed off and fits into impeller body 32. The upper end of shaft 50' extends upwardly through cover plate 18. Outer shaft 50' is cemented to a protective ceramic sleeve 78' to form a single integral part of shaft assembly 20 together with graphite shaft 50', spacer shield 52, steel driving shaft 24 and tongue 58.

Figures 5-6 show various forms of an unshielded vertical leg that can be mounted between the pump housing 30 and cover plate 18 in order to lock the pump legs to the pump housing without the use of load-carrying cements, eliminating the need for large clearances between the legs and post sockets. Graphite cement is used only as a sealant to prevent molten metal penetration.

Graphite leg 120 has an upper end fastened to the cover plate by a threaded fastener 122. The lower end of the leg is received in a cylindrical socket 124 in the pump housing. The leg's lower end has an annular enlargement 126 which is bottomed in the socket. The leg has an annular groove 128 above the enlargement for receiving a close fitting split ring 130. The socket also has an annular groove 132 for receiving the split ring.

In this embodiment of the invention, the lower end of the leg is inserted into the socket by squeezing the split ring into groove 128. Once the split ring is disposed in the socket, the shaft is pushed down until the split ring snaps into groove 132 thereby being disposed in both the groove in the leg and the groove in the socket, locking the leg in position.

Figure 6 illustrates another embodiment of the invention in which a vertical leg 140 has an annular groove 142 for receiving a close fitting split ring 144. The pump housing 30 has a socket 146. The upper edge of the socket is chamfered as at 148 in such a manner that as the leg is inserted into the socket, the chamfered edge squeezes the split ring into the groove 142. The leg is moved further into the socket until the split ring is partially expanded into the annular groove 150 in the socket. The split ring is disposed in both the socket of the leg and the groove of the socket thereby locking the leg to the housing.

In Figure 8, housing 30 has a generally cylindrical socket with a radial groove 162. The upper wall of the groove is adjacent a chamfered lip 164. Split ring 166 is

placed in groove 162. When leg 168 is pushed into socket 160, ring 166 will expand, then snap into groove 170.

Figures 8A and 9 illustrate another version of a leg-housing locking device. Leg 171 has a groove 178 connected by means of passage 174 to an opening 180 located above the upper surface of housing 182. Housing 182 has an annular groove 176. After leg 171 is inserted in housing socket 172, graphite cement is injected under pressure in opening 180 and via passage 174 fills the cavity generated by grooves 176 and 178 in the housing and leg respectively, thus, preventing, after hardening, any axial displacement of the leg with respect to the housing.

Figure 10 illustrates a shielded upright quill leg for supporting pump housing 30 beneath a cover plate 18. An opening 181 is formed in housing 30. An outer ceramic tubular shield 183 if formed with a length sufficient so that its lower blind end extends below the inside surface of the wall of housing 30. The upper end abuts cover plate 18.

An inner ceramic tubular shield 188 is disposed inside the outer shield and cemented along the length and around the inner shield in the area 190 (indicated by the heavier line). The lower end of the inner shield extends above the bottom of the outer shield. The upper end of the outer shield is located by an annular mounting member 192 that is attached to the cover plate. The lower end of the outer shield is threaded at 194 to receive a locking nut 196 which is screwed up to abut the inside surface of the housing.

A stainless steel leg 198 is disposed in the inner shield. The lower end of the stainless steel leg has a radial enlargement 200 which has a diameter less than the inner diameter of the outer shield but greater than the inner diameter of the inner shield so that it abuts the lower edge of the inner shield. Leg 198 is located so as to form an annular chamber 201 between the leg and the inner shield to permit the leg to thermally expand when it is disposed in the molten metal bath, without imposing an expansion stress on the shields.

The upper end of the leg is threaded at 202 for receiving a locking nut 204 and bevel washer 206 in order to lock the leg in position when it has been properly located within the ceramic shield.

Figure 11 illustrates a slightly modified version of the shielded leg of Figure 10. In this case a tubular shield 210 comprises inner and outer ceramic shields similar to those illustrated in Figure 10, and an internal stainless steel leg. The lower end of the outer shield has an enlargement 212 sequestered inside a corresponding similar enlargement in the housing instead of using nut 196 with the threaded configuration.

Figure 11A illustrates a quill leg that is identical to that of Figure 11 except that it has been cemented to pump housing 30 in accordance with common post-cementing procedures known by a person skilled in the art.

Figure 12 illustrates another version of a shielded leg 220 for supporting pump housing 30 beneath cover plate 18. This particular design utilizes graphite components in combination with a ceramic outer sleeve to protect the graphite outer shield. Although the graphite components of the leg are protected by the heat resistant

ceramic shield, in some cases the air chamber between them or air leakage provides sufficient oxygen to allow the support leg components to burn.

In this case, a stainless steel leg 222 has an enlargement 224 carried at its lower end mounted within an inner graphite tubular shield tube 226. The enlargement is seated against the lower end of the inner shield. The upper end of the leg is threaded at 228 to engage a fastening nut 230 and bevel washers 232 in such a manner that by tightening on nut 230, enlargement 224 firmly seats the leg in position against the bottom of the cover plate to form a gas chamber 234 around leg 222.

An intermediate tubular graphite shield 236 telescopically receives the inner shield and has its internal surface cemented to the inner shield.

Leg 222 has a longitudinal gas passage 242 that extends from its upper end down to its lower end and also radially out through an opening 244 into chamber 234.

The inner shield, in turn, has a small passage 246 which communicates with a passage 248 in shield 236.

An outer ceramic tubular shield 250 encloses both of the graphite shields and has an internal annular chamber 252 in communication with passage 248. Chamber 252 is filled with molten metal resistant cement. A source of nitrogen 254 is connected to passage 242 to form an oxygen-free atmosphere around the leg as well as an oxygen-free atmosphere along and around the graphite shields exposed to the metal level to prevent the graphite shields from burning.

Figures 13-15 illustrate a combination dynamic filter and pumping vane member 300 that may be substituted for the pumping member 32 illustrated in Figure 1.

Pumping vane member 300 has an opening 302 for receiving the lower threaded end of pumping shaft 42. A nut 303 attaches the body to the pumping member 300. Pumping element 300 thus rotates with driving shaft 24.

The pumping member has an internal chamber 304 with outlet opening means 306 and an apertured bottom strainer plate 308. The strainer plate has an annular outer series of openings 310 and an inner series of openings 312. The inner series of openings are in a bottom horizontal portion of the strainer plate while the outer inlet openings are in a frusto-conical wall.

Referring to Figure 15, the pumping member has a series of pumping vanes 314 which are curved to form openings each having a width A in such a manner that as the pumping member is rotated, the pumping vanes draw the liquid metal through the inlet openings and then push the liquid metal out through the outlet opening means 306. Strainer openings 310 and 312 have a maximum diameter B that is smaller than the larger openings A between the vanes. Thus the strainer openings prevent debris having a size larger than strainer openings B from entering into the pumping chamber thereby preventing any clogging of the vane openings.

A series of inner linear radial slinger bars 320 and outer radial slinger bars 322 are mounted on the strainer plate between adjacent strainer openings to strike any relatively large debris attempting to enter the strainer openings before they reach the vane openings. The slinger vanes strike the debris thereby permitting the pump to be located closely adjacent the bottom of the molten metal pot thereby permitting a stream of inlet liquid metal to be generated at a lower level in the pot.

Thus, it is to be understood that several variations have been described of an improved impeller-type pump useful in molten metal baths as well as several variations of shielded legs for supporting the pump in the molten metal bath.

Having described my invention, I claim:

Claims

1. Apparatus for moving a stream of molten metal in a bath of the molten metal comprising:

a pumping member adapted to be disposed in a bath of a heated molten metal, and to move a stream of the molten metal as the pumping member is driven in a path of motion;

a housing at least partially enclosing the pumping member;

a shielding means carried on the pump housing, the shielding means having an internal shaft-receiving opening;

a power device adapted to be supported above the bath of molten metal, and to be actuated in a powered motion;

means for connecting the power device to the pumping member to move the pumping member in said path of motion, comprising;

a pumping shaft having an upper end connected to the power device so as to be moved when the power device is actuated, and a lower driving end connected to the pumping member to drive the pumping member in said path of motion when the power device is actuated;

the driving end of the shaft having a first coefficient thermal expansion and the socket having a different coefficient of thermal expansion; and

the shaft means being disposed in the shielded means out of contact with the molten metal, and forming a chamber between the shaft and the

shielding means sufficient to permit thermal expansion of the shaft without imposing a radial thermal stress on the shielding means.

2. Apparatus as defined in claim 1, in which the pumping member is rotated in said path of motion.

3. Apparatus as defined in claim 1, in which the power device is a motor connected to the pumping shaft for rotating same.

4. Apparatus as defined in claim 1, in which the pumping member is an impeller pumping element.

5. Apparatus as defined in claim 1, in which the pumping shaft is made of a steel alloy with sufficient torque characteristics to rotate the pumping member in the molten metal.

6. Apparatus as defined in claim 5, in which the pumping shaft is made of stainless steel.

7. Apparatus as defined in claim 1, in which the shielding means comprises an elongated tubular shield telescopically enclosing the pumping shaft, the tubular shield having a lower end attached to the pump housing, and an upper end, the tubular

shield having a length such that the upper end is disposed above the metal surface of the bath of molten metal.

8. Apparatus as defined in claim 7, in which the pumping shaft is rotatably connected to the pumping member, and the tubular shield encloses the pumping shaft but does not rotate therewith.

9. Apparatus as defined in claim 7, in which the pumping shaft is formed of a steel alloy that has sufficient torque characteristics as to be capable of rotating the pumping member in the molten metal, and

the tubular shield is formed of a ceramic material with sufficient heat-resisting characteristics as to withstand the heat of the molten metal as the pumping member is being rotated.

10. Apparatus as defined in claim 7, in which the tubular shield includes:

an outer tubular shield having a lower end attached to the pump housing;

an inner tubular shield telescopically disposed in said outer tubular shield and being attached thereto;

the inner tubular shield having a bore with a diameter greater than the diameter of the pumping shaft, and enclosing the pumping shaft to form a chamber therearound;

the lower end of the inner shield forming a shoulder; and

structure disposed on the lower end of the shaft engaging the shoulder to locate the lower end of the shaft with respect to the inner shield.

11. Apparatus as defined in claim 7, in which the tubular shield means includes:

an inner tubular shield telescopically disposed in said outer tubular shield and being attached thereto;

the inner tubular shield having a bore with a diameter greater than the diameter of the shaft, and enclosing the shaft so as to form a chamber therearound;

the lower end of the inner tubular shield being spaced from the lower end of the outer tubular member to form a driving chamber;

a driving structure supported on the lower end of the shaft enclosed within the outer shield; and

cement disposed in the outer shield having a socket accommodating the configuration of said driving structure, the driving structure being disposed in said socket but having a clearance therebetween to accommodate the relative thermal expansion characteristics of said driving structure and the socket, but permitting the driving structure to be rotated to engage the socket wall in the cement to rotate the pumping member.

12. Apparatus as defined in claim 11, in which the driving structure has a tongue-shaped configuration.

13. Apparatus as defined in claim 11, in which the driving structure is threadably attached to the lower end of the shaft.

14. Apparatus as defined in claim 11, in which the driving structure is integrally attached to the lower end of the shaft.

15. Apparatus as defined in claim 11, in which the clearance between the driving structure and the socket is formed by the steps of:

forming the outer tubular shield with a lower blind end;

disposing a cement in the blind end of the outer tubular shield to form a socket having the configuration similar to but larger than that of the driving structure;

disposing a wax that turns to a gas when exposed to the heat in the bath of molten metal, in said socket;

disposing the driving structure in the wax; and

telescopically inserting the inner tubular shield in the outer tubular shield to engage the driving structure, and cementing the inner tubular shield to the outer tubular shield to form a unitary tubular shield around the pumping shaft.

16. A combination, comprising:

pot means for containing a bath of molten metal;

a pumping member adapted to be disposed in a bath of a heated molten metal, and to move a stream of molten metal as the pumping member is driven in a path of motion;

a housing at least partially enclosing the pumping member;

a shielding means carried on the pump housing, the shielding means having an internal shaft-receiving opening;

a power device adapted to be supported above the bath of molten metal, and to be actuated in a powered motion;

means for connecting the power device to the pumping member to move the pumping member in said path of motion, comprising;

a pumping shaft having an upper end connected to the power device so as to be moved when the power device is actuated, and a lower driving end connected to the pumping member to drive the pumping member in said path of motion when the power device is actuated;

the driving end of the shaft having a first coefficient of thermal expansion and the socket having a different coefficient of thermal expansion; and

the shaft means disposed in the shielding means out of contact with the molten metal, and forming a chamber between the shaft and the shielding means sufficient to permit thermal expansion of the shaft without imposing a radial thermal stress on the shielding means.

17. A combination comprising:

pot means for containing a bath of molten metal;

a pumping member adapted to be disposed in a bath of a heated molten metal, and to move a stream of the molten metal as the pumping member is driven in a path of motion;

means on the pumping member forming a socket;

a power device adapted to be supported above the bath of molten metal, and to be actuated in a power of motion;

means for connecting the power device to a pumping member to move the pumping member in said path of motion, comprising;

the tubular shield enclosing the shaft.

18. Apparatus for moving a stream of molten metal in a bath of the molten metal comprising:

a pumping member adapted to be disposed in a bath of a heated molten metal, and to move a stream of the molten metal as the pumping member is driven in a path of motion;

a power device adapted to be supported above the bath of molten metal, and to be actuated in a powered motion;

means for connecting the power device to the pumping member to move the pumping member in said path of motion, comprising;

a shaft adapted to be connected to the power device to be rotated thereby;

a shield means of a heat resistant material telescopically receiving the shaft and having a length longer than the shield means so that the lower end of the shield means extends beyond the lower end of the shaft

means connecting the shaft to the shield means to rotate the shaft and shield together; and

means connecting the shield means to the pumping member to rotate the shield means and the pumping member together.

19. Apparatus as defined in claim 18, in which the pumping member is rotated in said path of motion.

20. Apparatus as defined in claim 18, in which the power device is a motor connected to the shaft for rotating same.

21. Apparatus as defined in claim 18, in which the pumping member is an impeller pumping element.

22. Apparatus as defined in claim 18, in which the shaft is made of a steel alloy with sufficient torque characteristics to rotate the pumping member in the molten metal.

23. Apparatus as defined in claim 18, in which the shaft is made of stainless steel.

24. Apparatus as defined in claim 18, in which the shaft is formed of a steel alloy that has sufficient torque characteristics as to be capable of rotating the member in the molten metal, and

the shield means is formed of a ceramic material with sufficient heat resisting characteristics as to withstand the heat of the molten metal as the pumping member is being rotated.

25. Apparatus as defined in claim 18, including a pump housing at least partially enclosing the pumping member, and in which the tubular shield means includes an outer tubular shield having a lower end attached to the pump housing; and

an inner shield telescopically disposed in said outer tubular element and being cemented thereto the shaft being connected to the inner shield.

26. Apparatus as defined in claim 18, including a pump housing at least partially enclosing the pumping member, and in which the shield means includes:

an outer tubular shield having a lower end attached to the pump housing,

an inner tubular shield telescopically disposed in said outer tubular shield and being cemented thereto;

the inner tubular shield having a bore with a diameter greater than the diameter of the pumping shaft, and enclosing the pumping shaft so as to form a chamber therearound;

the lower end of the inner tubular member being spaced from the lower end of the outer tubular member to form a shoulder;

a structure disposed adjacent the lower end of the drive shaft having a diameter greater than the diameter of the bore of the inner tubular shield but less than the diameter of the outer shield to form a shoulder, and the structure engages the shoulder to locate the lower end of the shaft with respect to the tubular shield; and

cement disposed in the lower end of the outer shield with a socket accommodating the configuration of the lower end of the shaft but having a clearance therebetween to accommodate the relative thermal expansion characteristics of said driving end to be rotated into the socket to rotate the pumping member.

27. Apparatus as defined in claim 26, in which the lower end of the shaft has a tongue-shaped configuration.

28. Apparatus as defined in claim 26, in which a clearance between the lower end of the shaft and the socket is formed by the steps of:

forming the outer shield with a lower blind end;

disposing a cement in the blind end of the outer tubular member to form a socket having the configuration similar to but larger than that of a driving end;

disposing wax that turns to gas when exposed to a heat in the bath of molten metal in said socket;

disposing the lower driving end of the shaft in the wax;

inserting the inner tubular member into the outer tubular member so as to engage the driving end of the pumping shaft, and

cementing the inner tubular member to the outer tubular member to form a unitary tubular shield around the shaft.

29. Apparatus as defined in claim 18, in which the shield means comprises an inner tubular graphite shield telescopically receiving the shaft;

an outer tubular graphite shield telescopically receiving the shaft and the inner tubular graphite shield; and

a tubular shield telescopically receiving the shaft, the inner graphite shield and the outer graphite shield.

30. Apparatus for moving a stream of molten metal in a bath of molten metal having a metal level, comprising:

power means adapted to be supported above the metal level of the bath;

a shaft having an upper end connected to the power means for rotation thereby, and a lower end;

a pump housing adapted to be disposed in the bath of molten metal;

the pump housing having a pumping chamber;

a pumping member disposed in the pumping chamber and connected to the lower end of the pumping shaft for rotation therewith to produce a stream of the molten metal;

the housing having a bottom inlet opening for receiving the molten metal into the pumping chamber;

strainer means mounted on said inlet opening; and

the housing having feet for supporting the housing above the floor of a pot containing a molten metal such that the bottom opening faces toward the floor of the pot when receiving molten metal therein through the inlet opening.

31. Apparatus for moving a stream of a molten metal in a bath of molten metal, comprising:

power means adapted to be supported above the metal level of the bath;

a shaft having an upper end connected to the power means for rotation thereby, the shaft having a lower end;

a pump housing;

the pump housing having a pumping chamber, an inlet opening for receiving molten metal into the pumping chamber;

a strainer disposed in said inlet opening and having strainer openings with a diameter chosen to prevent the entry of debris of a maximum diameter into the pumping chamber; and

the pumping member connected to the pumping shaft for rotation therewith, the pumping member having pumping vanes for moving the molten metal, the vane having vane openings therebetween greater than the strainer openings, whereby debris entering the inlet opening is smaller than the vane openings between the vanes.

32. Apparatus for moving a stream of molten metal in a bath of molten metal comprising:

a pumping member adapted to be disposed in a bath of heated molten metal and to move a stream of molten metal as the pumping member is driven in a path of pumping motion;

a power device adapted to be supported above the bath of molten metal and to be actuated in a powered motion;

means for connecting the power device to the pumping member to move a pumping member in said path of pumping motion;

a pump housing having a pumping chamber and an inlet opening, the pumping member being disposed in the pump housing, the inlet opening being adapted for receiving molten metal into said pumping chamber;

the pumping member having a strainer plate having apertures for receiving molten metal into the pumping chamber as the pumping member is being rotated about an axis of rotation; and

a slinger rib mounted on the strainer plate adjacent the apertures and upstream thereof so as to strike debris carried into the stream toward the apertures, in a direction away from said inlet opening as the pumping member is being rotated.

33. Apparatus as defined in claim 32, in which the strainer plate has a convex configuration including a planar bottom bounded by a frusto-conical side wall, and the planar bottom has said apertures, and including other apertures in the frusto-conical side wall.

34. Apparatus as defined in claim 33, in which the slinger rib is mounted between the apertures in the slinger bottom, and including another slinger rib mounted on the frusto-conical wall between the apertures therein.

35. Apparatus for moving a stream of molten metal in a bath of the molten metal beneath overhead structure, comprising:

a pump housing adapted to be disposed in a bath of molten metal below the metal level;

leg means disposed between the pump housing and the overhead support structure, comprising:

a steel alloy leg having an upper end and a lower end, the leg having a sufficient compressive strength to prevent the pump housing from rising in the molten metal;

means for connecting the leg to the overhead support structure;

a tubular shield means enclosing at least a portion of the leg, and being formed of a material resistant to the heat of the molten metal; and

the tubular shield means having a lower end attached to the pump housing, and an internal bore having a diameter greater than the diameter of the leg to accommodate the leg's thermal expansion caused by the heat in the molten metal bath.

36. Apparatus as defined in claim 35, in which the pump housing has an opening, the tubular shield has a lower end disposed in said opening, and structure on the lower end of the shield for preventing withdrawal of the shield through said opening.

37. Apparatus as defined in claim 36, in which said structure comprises a nut threadably mounted on the lower end of the shield.

38. Apparatus as defined in claim 36, in which the structure is an integral enlargement carried on the lower end of the shield, said enlargement being larger than the opening in the housing.

39. Apparatus as defined in claim 36, in which the tubular shield is made of a heat-resistant ceramic.

40. Apparatus as defined in claim 36, in which the shield means comprises an outer ceramic tubular shield, and an inner ceramic tubular shield telescopically received in the outer shield and cemented thereto, the inner shield being shorter than the leg whereby both ends of the leg extend beyond the ends of the inner shield, and upper fastener means are connected to the upper end of the leg and engageable with the upper end of the inner shield, and lower fastener means threadably fastened to the lower end of the leg and engaged with the lower end of the inner shield for cooperating with the fastener means in locating the leg in the bore of the inner shield.

41. Apparatus as defined in claim 40, in which the bore of the inner shield, and the leg form a gas chamber, and including means for introducing an inert gas into the gas chamber to form an oxygen-free environment around the leg.

42. Apparatus for moving a stream of a molten metal in a bath of the molten metal, comprising:

overhead structure disposed above the molten metal level;

a pump having a housing, the housing having an upwardly facing socket;

a vertical leg disposed between the overhead structure and the pump housing;

the socket having a cylindrical side wall and an annular groove therein;

the leg having an annular groove; and

a split retaining ring carried in the groove of the leg and in the annular groove in the socket to prevent removal of the leg from the socket.

43. Apparatus as defined in claim 42, in which the split ring is diametrically resilient so as to be squeezed toward the base of the groove in the leg to permit passage of the ring into the socket opening.

44. Apparatus as defined in claim 42, in which a socket has a chamfered opening to assist in squeezing the ring into the groove in the leg as the leg is being passed into the socket.

45. Apparatus for moving a stream of a molten metal in a bath of the molten metal, comprising:

overhead structure disposed above the molten metal level;

a pump having a housing, the housing having an upwardly facing socket;

a vertical leg disposed between the overhead structure and the pump housing;

the socket having a cylindrical side wall and an annular groove therein; and

including cement received in the groove in the socket for fastening the leg to the housing.

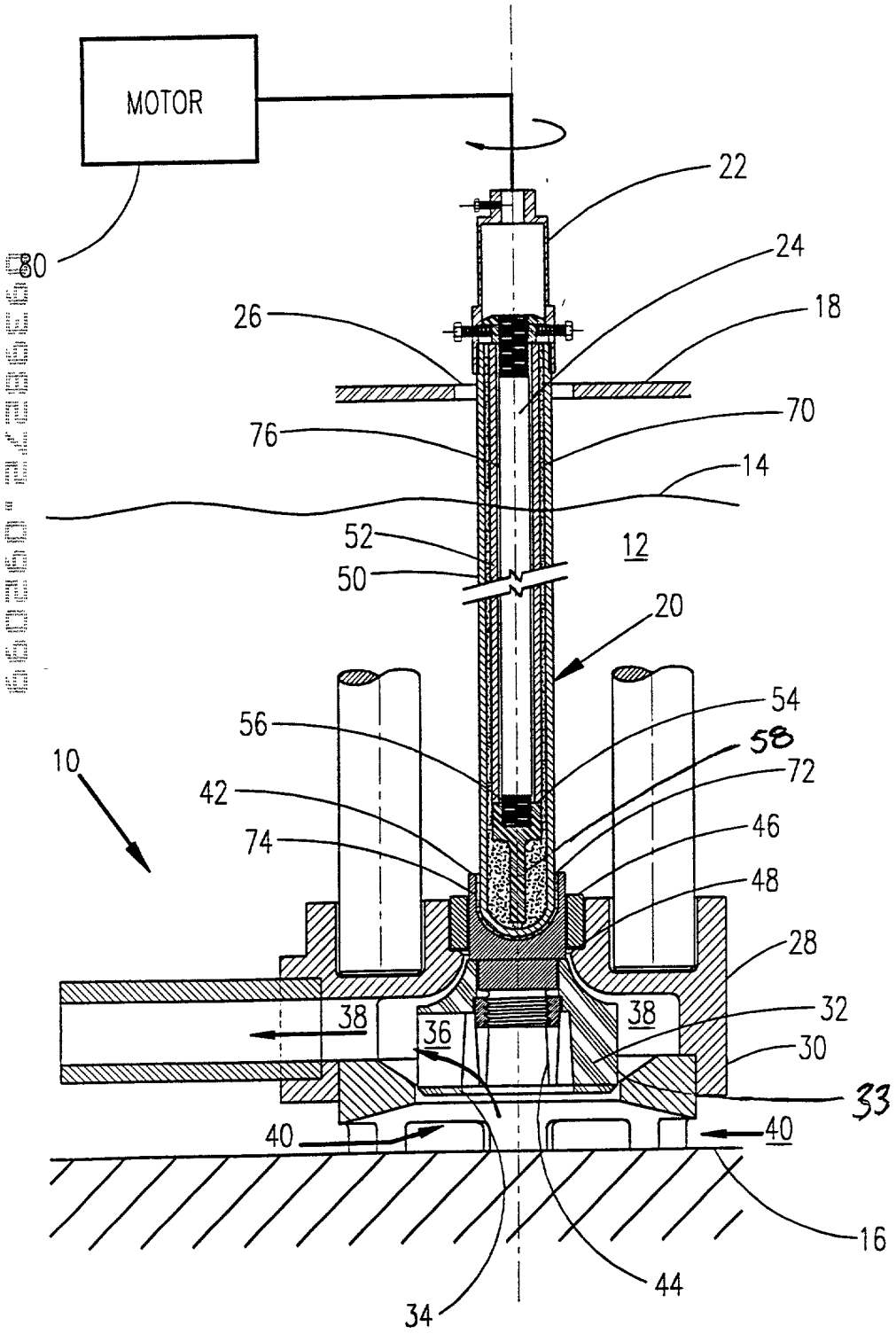

FIG. 1

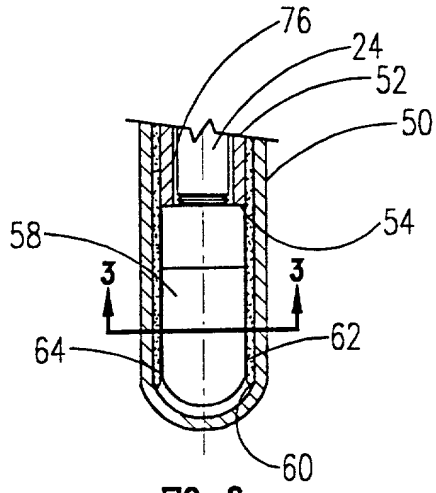

FIG. 2

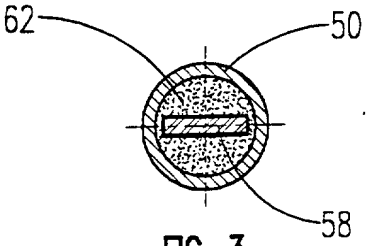

FIG. 3

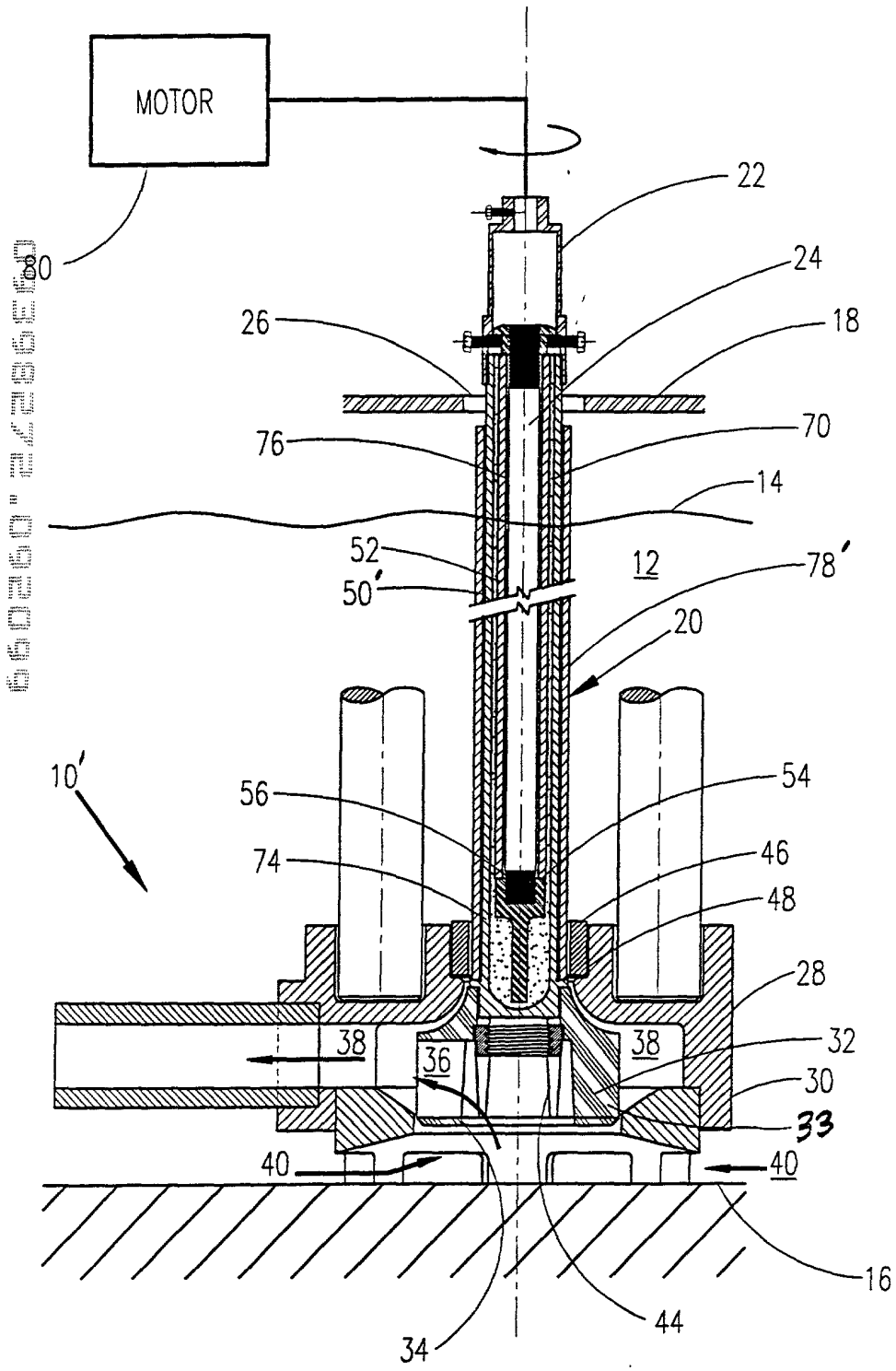
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FIG. 4

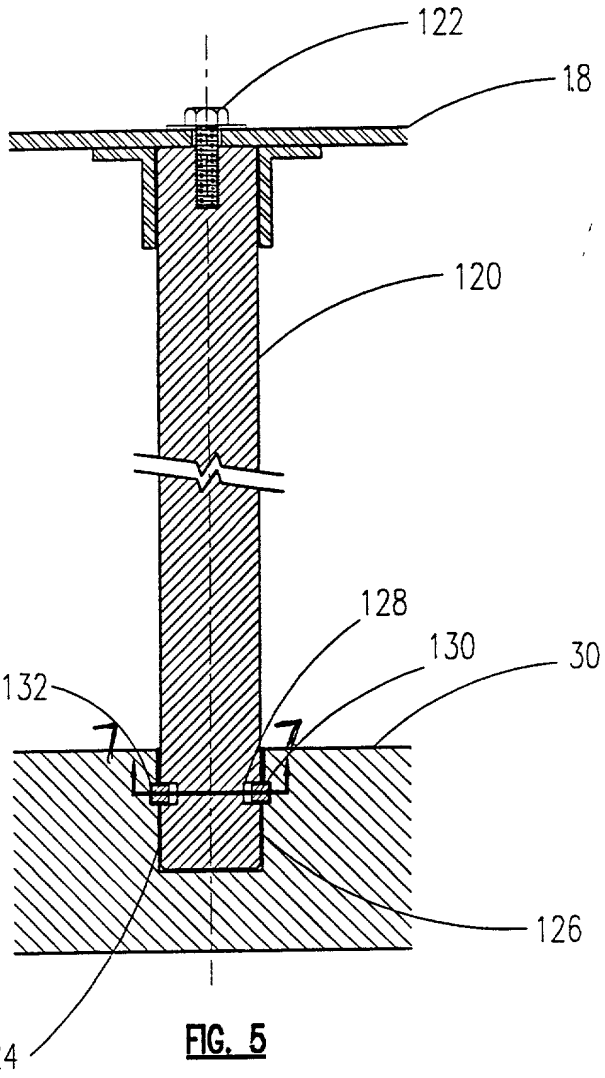

FIG. 5

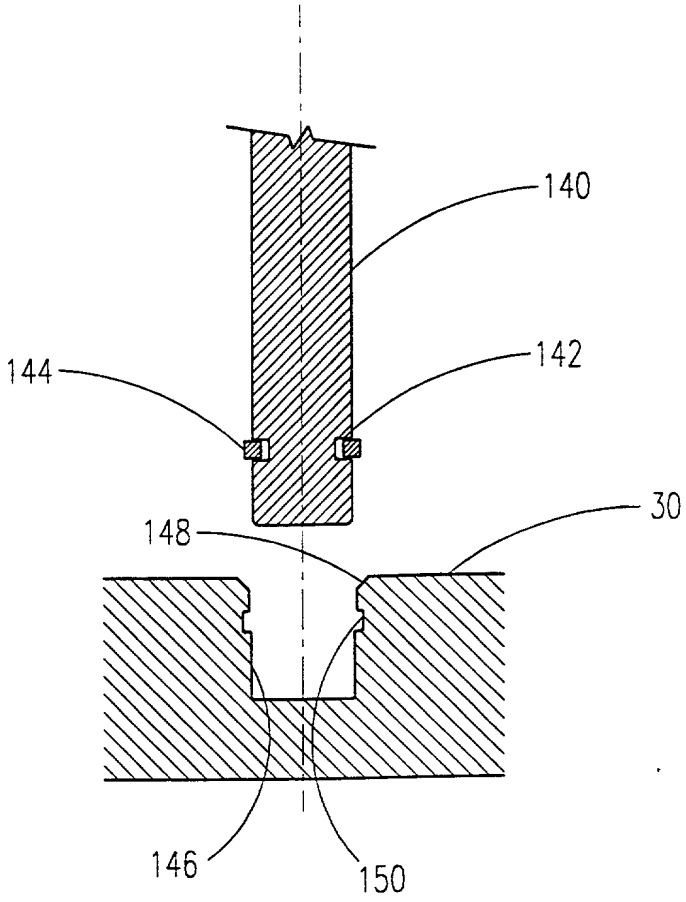

FIG. 6

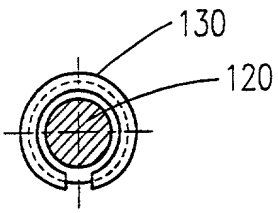

FIG. 7

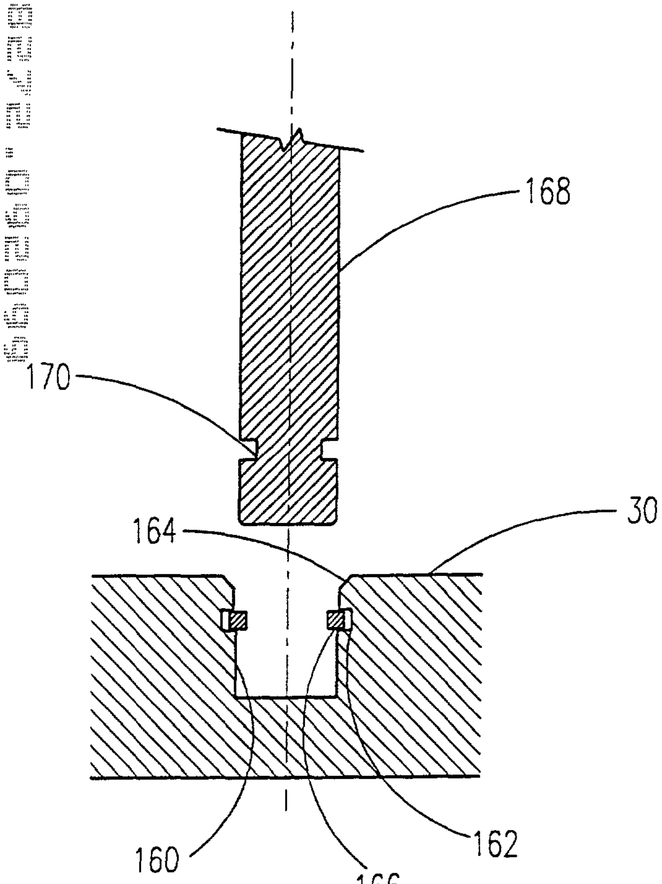

FIG. 8

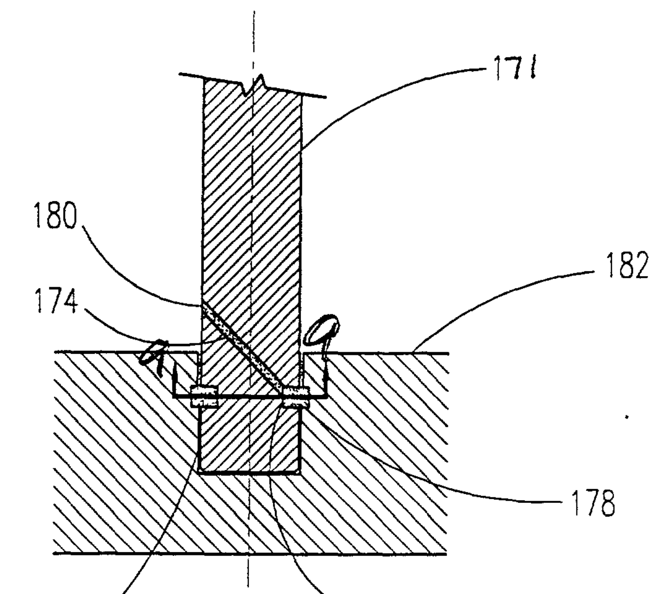

FIG. 8A

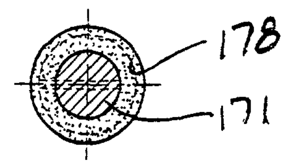

FIG. 9

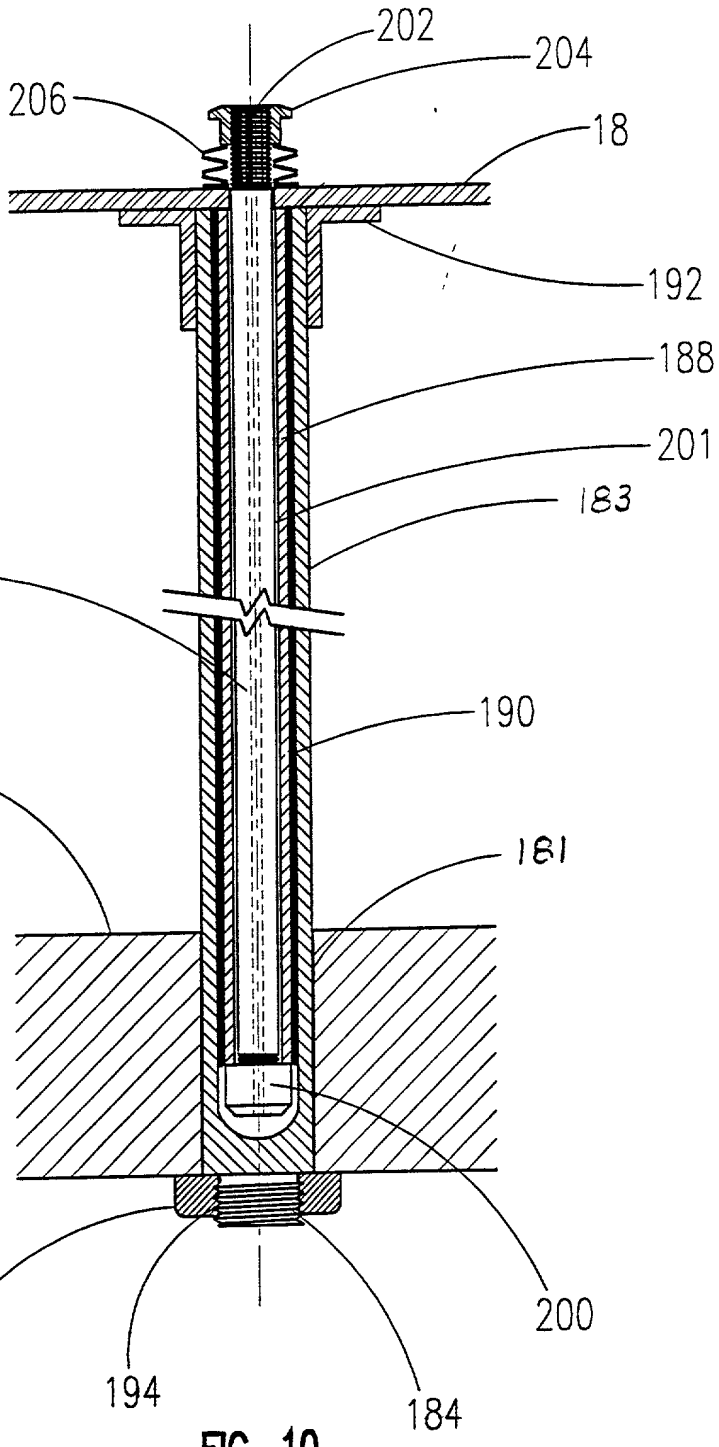

FIG. 10

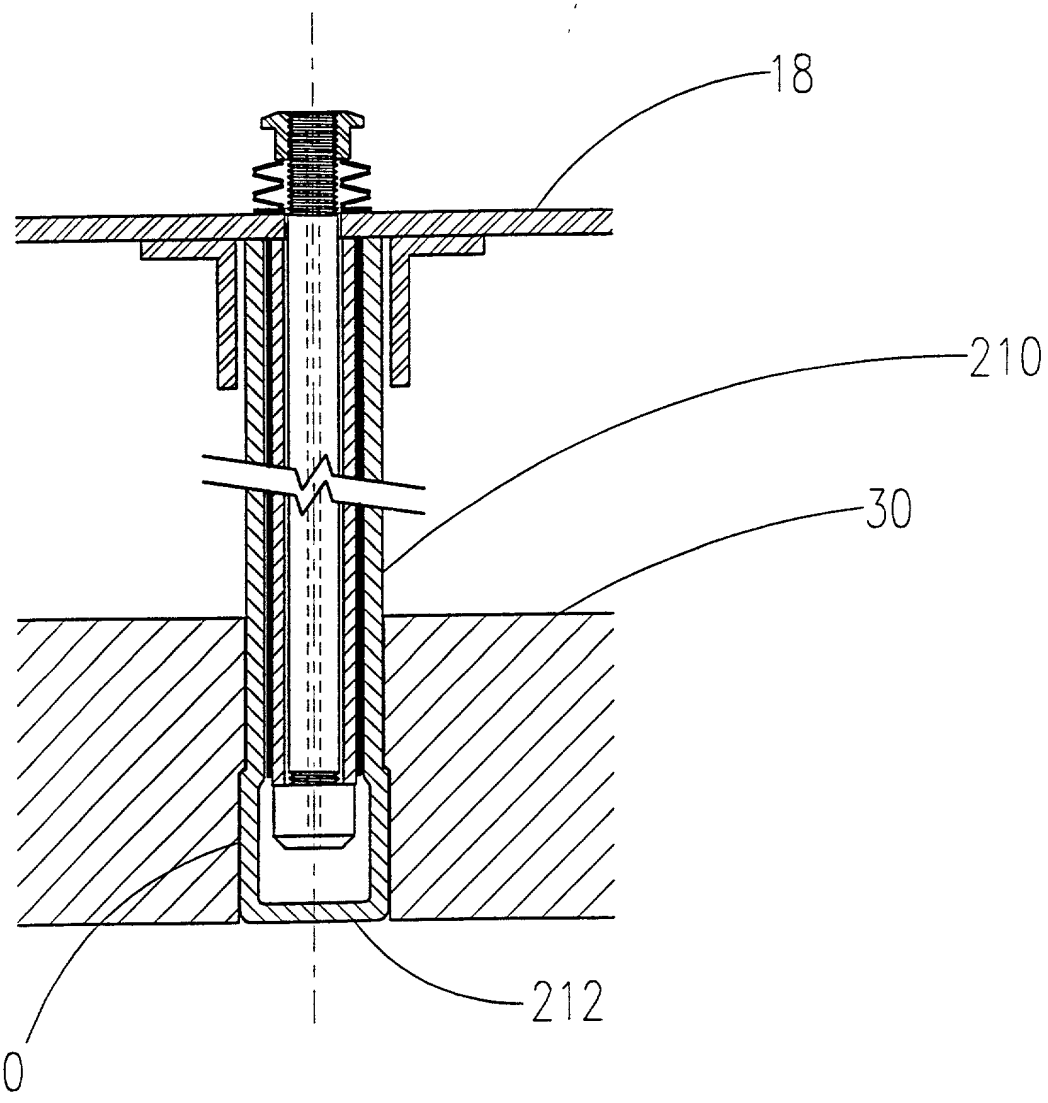

FIG. 11

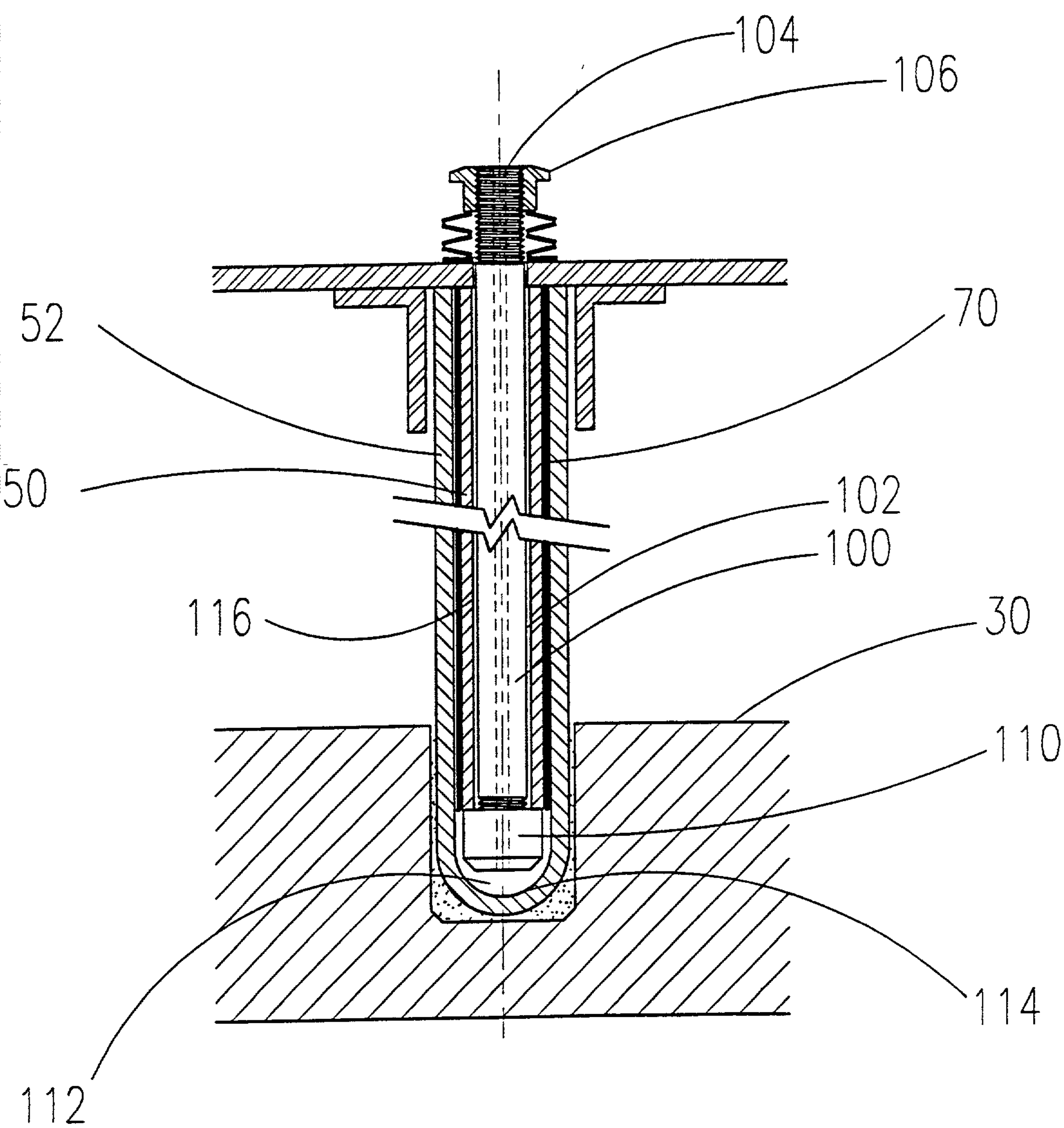

FIG.11A

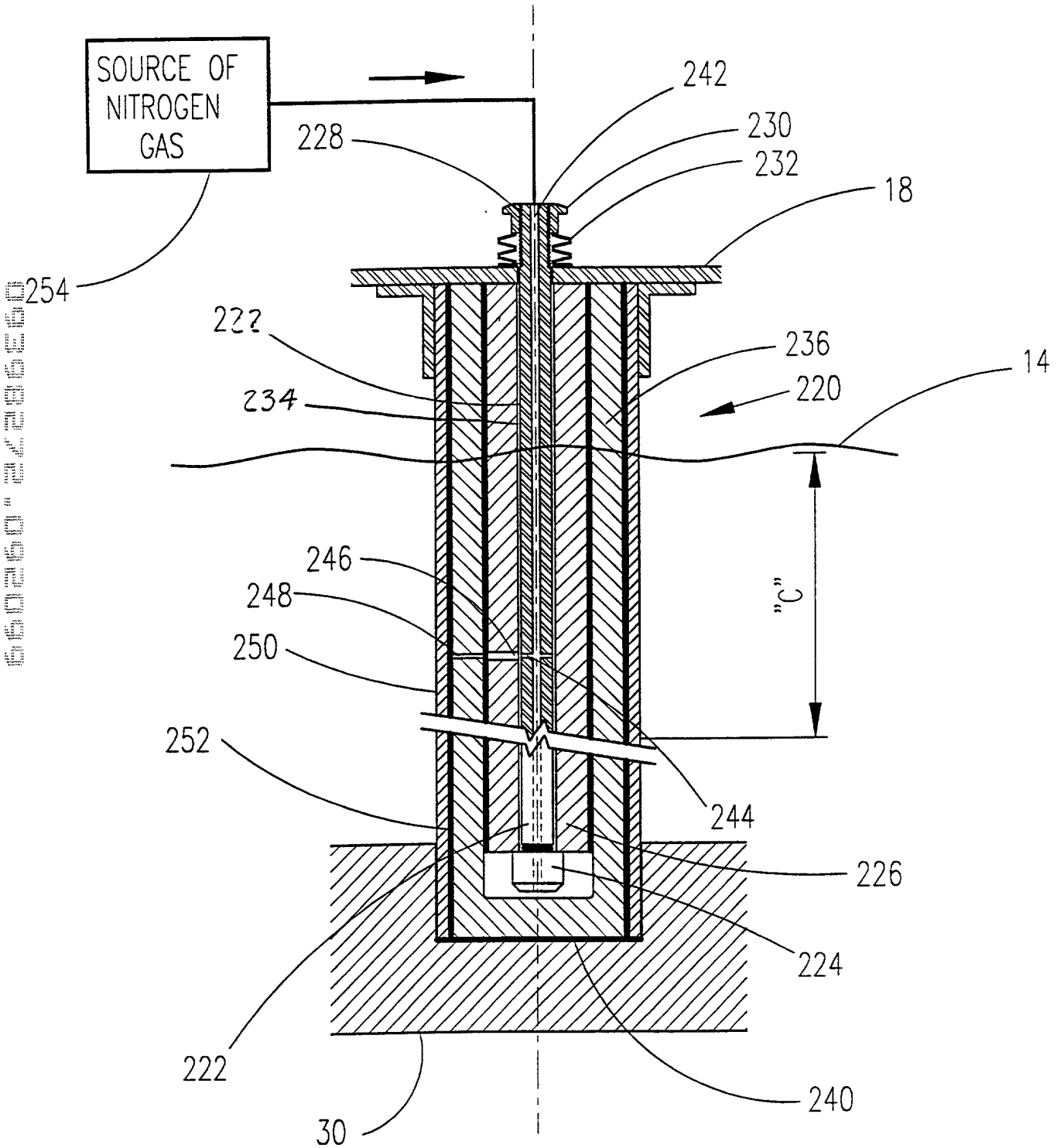
SOURCE OF NITROGEN GAS
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FIG. 12

FIG. 13

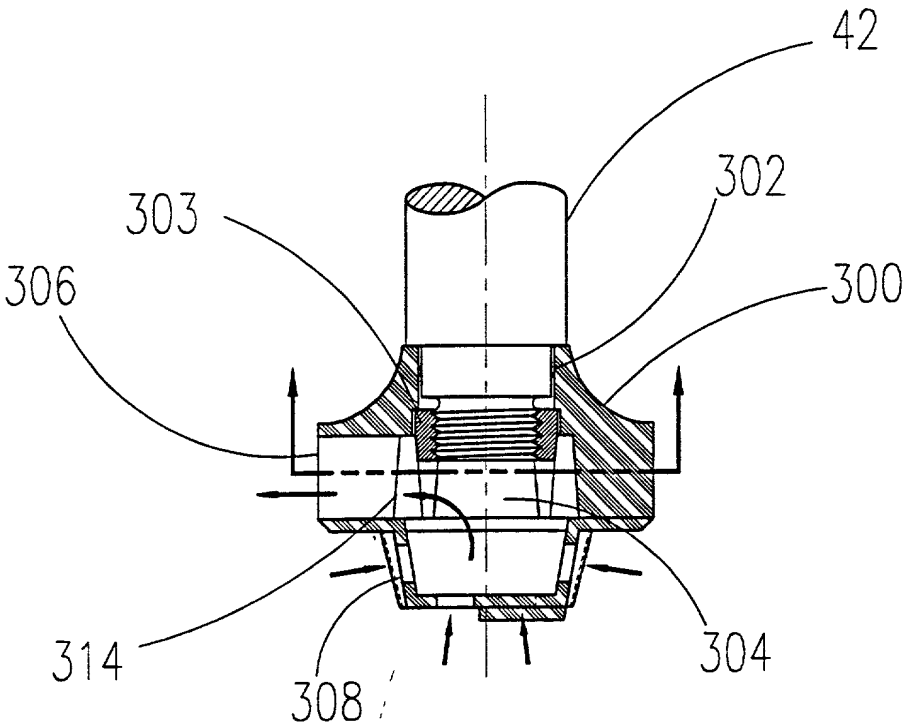


FIG. 14

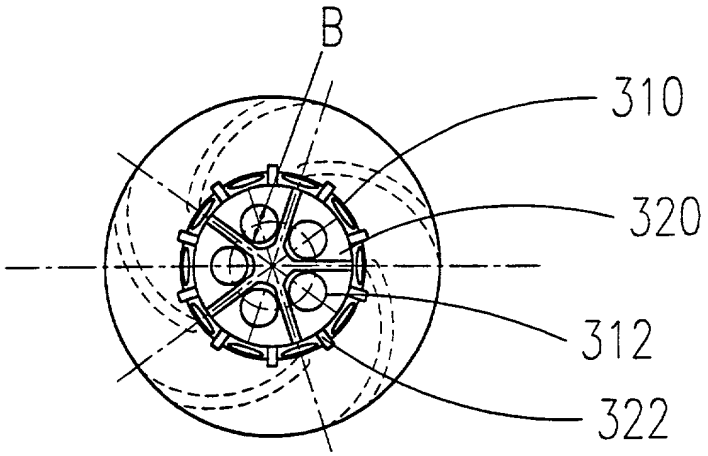
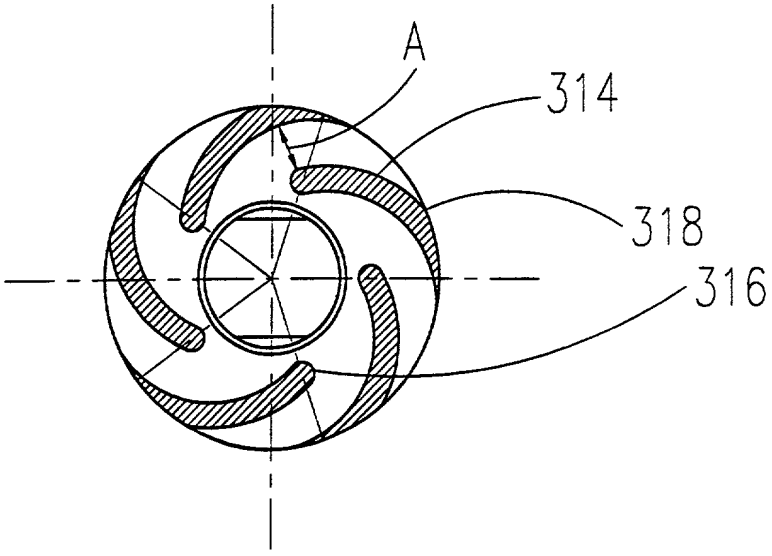


FIG. 15



PTO/SB/01 (6-95)
Approved for use through 9/30/98 OMB 0651-0032
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Rev. 6/95

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Patent and Trademark Office

DECLARATION FOR UTILITY OR DESIGN PATENT APPLICATION

☒ Declaration Submitted with Initial Filing OR ☐ Declaration Submitted after Initial Filing

Attorney Docket Number	MJV-117-A
First Named Inventor	Jorge A. Morando
COMPLETE IF KNOWN	
Application Number	
Filing Date	
Group Art Unit	
Examiner Name	

As a below named inventor, I hereby declare that:

My residence, post office address, and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled :

ADVANCED MOTOR DRIVEN IMPELLER PUMP FOR MOVING METAL IN A BATH OF MOLTEN METAL

(Title of the Invention)

the specification of which

☒ is attached hereto

OR

☐ was filed on (MM/DD/YYYY) _____ as United States Application Number or PCT International Application Number _____ and was amended on (MM/DD/YYYY) _____ (if applicable).

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment specifically referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in Title 37 Code of Federal Regulations, §1.56.

I hereby claim foreign priority benefits under Title 35, United States Code §119 (a)-(d) or §385(b) of any foreign application(s) for patent or inventor's certificate, or §365 (a) of any PCT international application which designated at least one country other than the United States of America, listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate, or of any PCT international application having a filing date before that of the application on which priority is claimed.

Prior Foreign Application Number(s)	Country	Foreign Filing Date (MM/DD/YYYY)	Priority Not Claimed	Certified Copy Attached? YES	Certified Copy Attached? NO
			☐	☐	☐
			☐	☐	☐
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			☐	☐	☐
			☐	☐	☐

☐ Additional foreign application numbers are listed on a supplemental priority sheet attached hereto:

I hereby claim the benefit under Title 35, United States Code §119(e) of any United States provisional application(s) listed below.

Application Number(s)	Filing Date (MM/DD/YYYY)	
		☐ Additional provisional application numbers are listed on a supplemental priority sheet attached hereto.

Type a plus sign (+) inside this b [+]

DECLARATION

Page 2

I hereby claim the benefit under Title 35, United States Code §120 of any United States application(s), or §365(c) of any PCT international application designating the United States of America, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT international application in the manner provided by the first paragraph of Title 35, United States Code §112, I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations §1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application.

U.S. Parent Application Number	PCT Parent Number	Parent Filing Date (MM/DD/YYYY)	Parent Patent Number (if applicable)

☐ Additional U.S. or PCT international application numbers are listed on a supplemental priority sheet attached hereto.

As a named inventor, I hereby appoint the following registered practitioner(s) to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith:

☐ Firm Name OR ☒ List registered practitioner(s) name and registration number below: Customer Number or label

Name	Registration Number	Name	Registration Number
Charles W. Chandler	24,290		

☐ Additional registered practitioner(s) named on a supplemental sheet attached hereto.

Please direct all correspondence to: ☒ Customer Number or label IDON304909 OR ☐ Correspondence address below

Name	Charles W. Chandler				
Address	33150 Schoolcraft				
Address					
City	Livonia	State	MI	ZIP	48150
Country	U.S.A.	Telephone	(734) 522-0920	Fax	(734) 522-5657

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Name of Sole or First Inventor: ☐ A petition has been filed for this unsigned inventor

Given Name	Jorge	Middle Initial	A.	Family Name	Morando	Suffix e.g. Jr.	
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Residence: City	Cadiz	State	KY	Country	U.S.A.	Citizenship	U.S.A.
Post Office Address	526 Riverview Trail						
Post Office Address							
City	Cadiz	State	KY	Zip	42211	Country	U.S.A.

Applicant Authority

☐ Additional inventors are being named on supplemental sheet(s) attached hereto